a dean of one of the institutions: The members of the United Medical Committee, in charge of the medical school of the University of Pennsylvania and the Jefferson Medical College, of Philadelphia, have agreed that it is advisable to postpone the consummation of the union agreed on by the plan adopted by the trustees of the two institutions, in order that further opportunity may be afforded for considering a number of important matters relative to the mode of administration of the new school, and have, therefore, determined that each of the schools shall conduct, separately from and independently of the other and of the United Medical Committee, the work of its college term for 1916–17.

Professor Walter S. Hunter, of the University of Texas, has been appointed professor of psychology in the University of Kansas, to fill the vacancy caused by the removal of Professor Robert M. Ogden to Cornell University.

At Indiana University, Professor W. N. Logan, director of the school of general science in the Mississippi Agricultural and Mechanical College, has been appointed associate professor of economic geology; and Mr. C. A. Malott has been appointed instructor in physiography and geology. Dr. J. J. Galloway, instructor in paleontology, has accepted a position as curator of paleontology at Columbia University.

Harrison R. Hunt, Ph.D. (Harvard, '16), has been appointed instructor in zoology in West Virginia University. He takes the place of J. Theron Illick, who will sail for China in the autumn to accept a teaching position there.

At the Michigan Agricultural College, Mr. G. R. Johnstone has resigned his instructorship in botany which he has held for three years, in order to prosecute his studies further. The vacancy has been filled by the appointment of Mr. H. C. Young, who was at the Missouri Botanical Garden last year.

We learn from *Nature* that the Manchester City Council (governing body of the Manchester School of Technology) has established a new subdepartment of the school of postgraduate study and research in coal-tar products and dyestuffs, and has appointed Professor A. G. Green, F.R.S., to take charge of it. Professor Green recently resigned the chair of tinctorial chemistry at Leeds University in order to direct the research department of a firm of dyestuff manufacturers. His subdepartment will be under the general direction of Professor Knecht, who is head of the department of applied chemistry, and is expert in the use of dyestuffs, as Professor Green is expert in their manufacture.

It is announced in the London *Times* that Dr. A. E. Evans, lecturer in chemistry in University College, Reading, has been placed in charge of a new department of the Huddersfield Technical College for special study and research in coal-tar color chemistry. It is expected that a number of scholarships will be tenable in the department. The directors of British Dyes (Limited) are supporting the scheme, and are prepared to contribute substantially towards its institution. At Leeds University there is already a department of color chemistry and dyeing, the endowment of which was provided by the Clothworkers' Company.

DISCUSSION AND CORRESPONDENCE

AN ENGINEER'S IDEA OF ENERGY

To the Editor of Science: In a recent number of Science[1] Professor Kent takes exception to some criticisms of mine on the "current definition of energy." In his opening sentences he states that in seeking "some language in which to convey to students an engineer's idea of energy" he wrote: "Energy, or stored work, is the capacity for performing work" and proceeded to extend and illustrate his definition.

Now if he had only "stuck to his idea" and prefaced his statement in his book with the words he here uses in his above explanation, so that his statement would have read: "An engineer's idea of energy, or stored work, is the capacity for performing work, etc.," no one could have taken exception to his statement. It would have been *true* and, except by other engineers, not open to dispute. But when he

[1] June 9, 1916, p. 820.

assumes that his statement is a generalized one and offers it as a "definition" of energy and not as a mere statement of the meaning he wishes to have attached to a term, he lays himself open to criticism. For it *is not true* as a general definition. The quoted statement from Maxwell to which I gave my approval, but which he condemns, shows a Maxwellian conception of energy. Professor Kent, himself, shows the futility of attempting to throw the Maxwellian conception into the form of a "definition." Professor Kent rejects the idea, or conception, of Maxwell because he can not throw it into the form of a "definition"; on the contrary, I reject the "definition" because it does not in any adequate way represent Maxwell's conception. Professor Kent seems to think that the statement which I quoted from Maxwell and which met my approval does not rise to the dignity of a conception because it does not fit his (Kent's) definition.

Further on, referring to matter and energy, Professor Kent declares:

> But there is a necessity for definitions of both these terms. The users of my book demand them.

The *naïveté* of this statement is delightful. I thought I was discussing a question of science and logic; Professor Kent seems to consider it one of "commerce and finance." However, in the opening paragraph, above, I have shown how he can "define" to his heart's content by merely specifically stating that such and such are the meanings that he wishes to have attached to the terms he uses and then use them consistently himself. When, however, he invades the fields of science and logic he must expect to be judged by the canons that hold in those fields. That is to say, other writers also use the terms matter and energy, but in a more general sense than is customary, or necessary, with the engineer. Professor Kent can not justly deny to others (Maxwell, for instance) a freedom which he claims for himself. It thus happens, of course, that different writers may use the same term in different senses, but that is a small thing compared to what happens when one and the same writer uses a term in two or more senses without perceiving that he is "mixing things up." It was not "definitions" *per se* to which I was objecting in my former communication, but to lop-sided, inadequate, or misleading statements intended as definitions, but which can result only in confusion and contradictions. Every writer is, and should be, free to "define" all the terms he pleases, provided only that so long as he continues to use a term he uses it consistently. Then the "survival of the fittest" will ultimately decide whether they survive or perish.

As regards the term "energy," in addition to its figurative meaning in literature it has developed two distinct technical meanings, the engineer's and the physicist's. This would not cause any great difficulty if the two technical meanings were distinctly recognized and indicated as is done with the "pound" in use as a unit in engineering practise. Professor Kent claims priority of use for the engineer's definition of energy. Granted, but priority in use can not justify a claim that the thing which he defines is the same thing as that which the physicist claims is conserved. Such a claim is exactly what I meant when I spoke of "mixing things up," or using the same term for two distinctly different things without recognizing that they *were* different. That Professor Kent's definition is consistent with the doctrine of the conservation of energy can not be admitted for a moment by any one who comprehends the meaning of the term conservation. "The capacity for performing work" *always* diminishes with the doing of work, for it *always* depends upon some existing differences, such as difference in temperature, difference in pressure, difference of level, difference in direction of motion, difference in direction of stresses, or even difference in molecular distribution as in the osmotic cell, which difference disappears when the possible work due to it is done. (Compare with Nernst's law.) The capacity for doing work may disappear entirely without diminishing the total energy of a system one particle. Hence, to claim that the capacity for doing work is conserved is tantamount to claiming that a perpetual motion machine is possible;

and the denial of such a possibility is a fundamental postulate of many writers on thermodynamics. The following statement of the postulate[2] may serve to bring out the significance of the differences referred to above:

> No engine of any kind can by any means be made to maintain continuously or restore and maintain when changed, the state of the system which initially set it in motion; and the difference in the energy state which initially established the motion will disappear the more quickly the greater the activity of the engine.

In reply to Professor Dadourian's objection in Science,[3] I would call his attention to the preceding remarks. In addition I would say that he misinterprets my point of view if he supposes that I am opposed to defining energy. If I knew how I would define it myself. Elsewhere[4] I have stated what I conceive constitutes the laws of energy; and those three laws are as near as I can come to a "definition of energy." If he can produce a definition that will convey the necessary information and not conflict with known facts and laws the scientific world will doubtless welcome it with open arms. The field is open. But a *definition that claims to be general* and leaves out, or even is in opposition to, the most important characteristic of the thing supposed to be defined is worse than no definition at all. The absence of a "definition" does not preclude the clarifying of our thought by diligent study of the thing we wish to define. As an aid to study, a provisional, or partial definition may often be of great assistance as a working hypothesis provided it is recognized as provisional and not allowed to close our minds to evidence and dominate our perceptive powers.

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"Available Energy" vs. "Energy"

To the Editor of Science: The argument between the scientist and the engineer over the definition of energy is clearly saturated enough to crystallize out the clean-cut definition of "available energy" and leave the indefinite but exceeding rich mother-conception of "energy" for those who shall see more clearly or be able to unite our bewilderment of facts and deductions to a concrete statement.

The communication of Professor Garver in the April 21 issue is both a timely and an excellent critique. Evidently he analyzed the difficulty far better than he constructed a working presentation or Dr. Wm. Kent would not have been able to so well establish himself in the reply of June 9.

That the author of a leading engineers' handbook should express himself as Kent has done may be considered as evidence to demonstrate the narrow conceptions and limited field into which practical men continually fall. From the energy-to-sell point of view there certainly is satisfaction in the Kent definition; but we can not allow Dr. Kent to confine the use of the term "energy" to engineering; the engineer clasps hands with the scientist in every undertaking and acknowledges his past and present effort as components of his own practicability.

The men who have most carefully studied thermodynamics and energy transformations assert that one particular sort of energy manifestation can be designated as *free* energy, *available* energy or by some factor indicating *potential* or *intensity* variation. The "stored work" is to be referred to this sort of energy, but the converse is not true—that all the energy in a given system which may thus be described can be converted into work. With Garver we have to say that a certain amount of work may be done during the *transfer* or adjustment of this sort of energy. Some energy is always lost, as heat when the work is done. We find, then, that Kent is careless in using "energy" where he should say "available energy" and he is inaccurate in assuming that *all* such energy is transformable into mechanical work.

Recent writers often state the matter with much conciseness:

[2] *Journal of Physical Chemistry*, Vol. 15, p. 613 (1911).

[3] June 16, 1916.

[4] *Loc. cit.*